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(54) ONE-SHOT ENERGY ABSORBING DEVICE

(71) We, JOHN ALBERT SEARLE, of "Southlands", Rectory Lane, Market Bosworth, Leicestershire and MICHAEL COLIN NASON, of 48 Manor Park Road, Nuneaton, Warwickshire, British Subjects, do hereby declare the invention, for which we pray that a patent may be granted to us, and the method by which it is to be performed, to be particularly described in and by the following statement:—

Energy absorbing devices are in use in many situations where it is desirable to cushion the impact between two objects, for example railway buffers, lift shaft emergency arrestors, motorway barriers, padding on car interiors, and the like. Energy absorbing devices which are used but seldom, such as in an accident or emergency, may be of the one-shot type. Such a device is damaged in the impact, and the device or a section of it must be replaced, but they are often justified on the grounds of low initial cost and low maintenance. This specification relates to an energy absorbing device of the one-shot type.

A further classification of energy absorbing devices is in accordance with the type of impact which they will absorb. An impact in a given line may be absorbed by a uni-directional device, such as an invertube, which would not be capable of absorbing much energy in an impact at an angle to its axis. Such a device can be employed, for example, as a lift shaft emergency arrestor. If the direction of impact is completely undetermined, an omni-directional device must be employed, such as a covering of foam padding. The present invention is intended primarily for an intermediate condition, when the impact is known to be in a given plane, although it can be used in other conditions at some loss in efficiency.

Finally, it should be noted that the present invention is intended for protection in high-energy impacts. Although it can be used for low-energy impacts, it is thought that it offers few advantages over known forms of energy absorber.

Turning now to known forms of energy absorber, it is well known in the packaging industry to make an energy absorber by sandwiching a honeycomb (e.g. of paper) between two sheets which are bonded to the outside of the honeycomb. This arrangement becomes prohibitively expensive at high energy levels, as the forces are high and the assembly, which must be made of metal, can no longer be bonded with adhesive.

It is also well known, for example in vehicle impact test work, to absorb energy by the axial crumpling of a tube (usually steel or aluminium). Such a method is cheap and efficient, but it requires the impact to be in a given line as the tube will otherwise fold over with little energy absorption, i.e. the device is uni-directional.

According to the present invention an energy absorbing device comprises a holder tube containing one or more energy absorbing tubes arranged transversely within the holder tube.

In a preferred embodiment, the holder tube has a rectangular cross-section and the energy absorbing tubes have circular cross-sections and are of a length which gives a clearance fit within the holder tube..

Six embodiments of the invention are shown, by way of examples only, in the accompanying drawings in which:

FIGURE 1 is a cut away view of a holder tube containing a single row of energy absorbing tubes arranged in one plane.

FIGURE 2 is a cut away view of a holder tube containing a single row of energy absorbing tubes arranged in two planes.

FIGURE 3 is a cut away view of a holder tube containing multiple rows of energy absorbing tubes arranged in one plane.

FIGURE 4 is a cut away view of a holder tube containing a single row of energy absorbing tubes arranged in one plane together with foam filling between these tubes.

FIGURE 5 is a cut away view of a holder tube containing a row of energy absorbing tubes arranged in one plane, together with a second row of energy absorbing tubes of smaller diameter contained within the first row.

FIGURE 6 is a cut away view of a holder tube containing a single row of

energy absorbing tubes arranged in one plane and incompletely filling the holder tube.

In Figure 1 the holder tube 1 contains a row of energy absorbing tubes 2 arranged in one plane. The device will absorb energy most effectively in the plane indicated by the arrows.

Figure 2 shows a similar arrangement in which every alternate energy absorbing tube 2 has been rotated through 90°. This enables the device to absorb energy in each of the two planes indicated by the arrows, and it is virtually omni-directional. As a consequence, however, its efficiency in any one plane is rather less than the Figure 1 arrangement.

Figure 3 shows a holder tube 1 containing multiple rows of energy absorbing tubes 2, arranged in one plane. Multiple rows provide better specific energy absorption than a single row, at the cost of some loss in stability when the device is impacted at an angle to the axes of the energy absorbing tubes.

Figure 4 shows an arrangement similar to Figure 1, with the addition of foam filling between the tubes introduced through the hole 3. Foam filling can also be provided within the tubes. The provision of foam filling can increase the stability of the energy absorbing tubes, and can also increase the specific energy absorption.

Figure 5 shows an arrangement similar to Figure 1, with the addition of a second row of energy absorbing tubes 2b within the first row 2a. Placing a second row within the first row increases specific energy absorption with no loss of stability.

Figure 6 shows an arrangement similar to Figure 1, but with the energy absorbing tubes too short to fill completely the holder tube. With the Figure 1 arrangement the initiation load for starting the collapse of the devise can be considerably higher than the steady state collapse load afterwards. This initiation load can be reduced by incomplete filling.

It should be noted that in carrying out the invention the type of arrangement, the dimensions and the materials must be chosen with regard to the intended application of the device. As an example a Figure 1 arrangement, made from a 4" square structural steel section of 0.162" wall, and filled with mild steel tubes of 0.062" wall thickness, will absorb approximately 20 ft tons per foot run crushed and will tolerate impacts in the plane of the axes of the energy absorbing tubes or at angles of up to 45 degrees to these axes. In particular applications several of the features illustrated, such as foam-filling, tubes-within-tubes, multiple rows, etc. can be combined to form an optimum arrangement.

WHAT WE CLAIM IS:—

1. An energy absorbing device comprising a holder tube containing one or more energy absorbing tubes arranged transversely within the holder tube.
2. An energy absorbing device according to Claim 1 in which the holder tube has a substantially rectangular cross section.
3. An energy absorbing device according to Claim 1 or Claim 2 in which the energy absorbing tubes have a substantially circular cross section.
4. An energy absorbing device according to any of the preceding claims in which at least one of the energy absorbing tubes is contained within another energy absorbing tube.
5. An energy absorbing device according to any of the preceding claims in which the axes of the energy absorbing tubes are all parallel with each other.
6. An energy absorbing device according to any of the preceding claims in which spaces between and within the energy absorbing tubes are filled with a foam material.

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1492752 COMPLETE SPECIFICATION
2 SHEETS *This drawing is a reproduction of the Original on a reduced scale*
Sheet 1

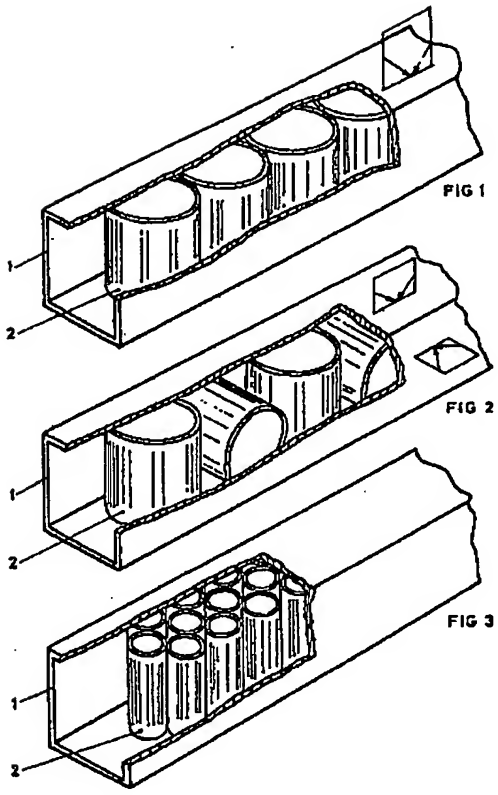

FIG 1

FIG 2

FIG 3

1492752 COMPLETE SPECIFICATION
2 SHEETS *This drawing is a reproduction of the Original on a reduced scale*
Sheet 2

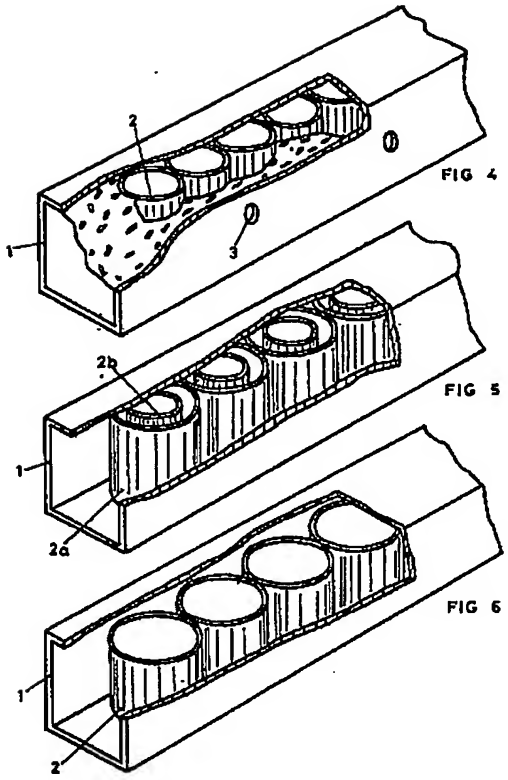

FIG 4

FIG 5

FIG 6